JP10259435 IRIDIUM BASE ALLOY

Date of publication of application : 29.09.1998
Application number : 09-117132
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Abstract:

PROBLEM TO BE SOLVED: To provide an iridium base alloy excellent in high temp. strength required as a heat resistant material in the high temp. region of =1100°C, furthermore excellent in oxidation resistance in the temp. range of 800 to 1050°C in the air and moreover remarkably improved in expansibility required for attaining plastic workability to thin the material.

SOLUTION: To pure iridium as a base a secondary element composed of one kind among platinum, palladium, rhodium, niobium, tantalum, hafnium, titanium, zirconium, yttrium, lanthanum and molybdenum is added in the solid solution range by 0.1 to 50 wt.% or several kinds of the secondary elements one compositely added in the solid solution range by 0.1 to 50 wt.%, to obtain the iridium base alloy which attains strength at low temps. and high temps. and, furthermore, improves oxidation resistance and expansibility at high temps.

[Claim(s)]
[Claim 1] iridium is used as the base -- platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- the iridium alloy which is dissolution within the limits about the second element which consists of any these one sorts, and is characterized by being dissolution within the limits and coming to carry out compound addition of addition or said second yuan prime factor kind.

[Claim 2] an iridium radical according to claim 1 -- setting -- platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- the addition of the second element which consists of any these one sorts -- or said second yuan prime factor kind of addition total amount -- respectively -- Iridium radical alloy characterized by holding down to dissolution [0.1 - 50wt% of] within the limits.

[Claim 3] iridium is used as the base -- as the second element -- a rhodium -- adding -- further -- as the third element -- platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- the iridium radical alloy which is dissolution within the limits, adds any these one sorts, and is characterized by the addition total amount of this third element and said second element being dissolution within the limits.

[Claim 4] an iridium alloy according to claim 3 -- setting -- rhodium of the second element 0.1 - 30wt% of within the limits -- adding -- further -- the platinum of the third element, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts -- dissolution [0.1 - 20wt% of] within the limits -- it is -- adding -- addition total amount of this third element and said second element Iridium radical alloy characterized by being dissolution within the limits which is 0.2 - 50wt%.

[Detailed Description of the Invention]

[0001]
[The technical field to which invention belongs] This invention relates to the heat-resisting material used for elevated-temperature devices, such as a energy development device, a space industrial use member, and crucible for the refractory material dissolution. As the concrete application, the gas turbine for a generation of electrical energy, a gas turbine blade, In a jet engine and a thermo-sensor list, personal-protective-equipment material and a semiconductor material, It is further related with the heat-resisting material with which reinforcement hot [, such as crucibles for the refractory material dissolution, such as a charge of ceramic industry lumber and a single crystal mould material of a glass lens, glass dissolution equipment, or a chemical fiber nozzle,], oxidation resistance, etc. are demanded, and the heat-resisting material used for burning-appliance structure material etc.

[0002]
[Description of the Prior Art] Conventionally, it is known that it is mainly a nickel radical alloy as this kind used for the gas turbine blade etc. of a heat-resisting material.

[0003]
[Problem(s) to be Solved by the Invention] By the way, the temperature which, as for a nickel radical alloy, can demonstrate the place the melting point of whose is 1300 degrees C of abbreviation to the reinforcement is about 1100 degrees C substantially, and 1100 degrees C is made into the operating critical temperature, i.e., durable temperature. Therefore, the activity in an elevated-temperature field 1100 degrees C or more of this nickel radical alloy becomes impossible.

[0004] Moreover, although a tantalum, niobium, molybdenum, a tungsten, platinum, pure iridium, etc. are known as a refractory material, as long as the refractory material which consists of an element of these kinds is used in a vacuum or an inert gas ambient atmosphere, reinforcement can be demonstrated by the pyrosphere to directly under [melting point], but in ambient atmospheres, such as inside of atmospheric air, and combustion gas, since oxidative consumption is carried out quickly, it cannot be used for the various applications mentioned above. by the way -- although the melting point is 2454 degrees C and a high refractory material when it sees paying attention to pure iridium -- since it is weak -- plasticity -- scarce -- for example, -- since it is very difficult to process it into about 0.5mm sheet metal, also restrict the application range -- ******. Furthermore, the oxidative consumption in the inside of atmospheric air will be intense, for example, will be exhausted from oxidizing violently in a 800-1050-degree C temperature requirement, and sublimating as an oxide (Ir O2 and Ir O3) into atmospheric air. However, if it becomes 1500 degrees C or more, since the oxide will be disassembled into a component, progress of oxidation can be suppressed. Therefore, since oxidative consumption of the refractory material which consists of pure iridium was carried out quickly in the 800-1050-degree C temperature requirement in atmospheric air and a combustion gas ambient atmosphere, it was a refractory material which lacks in practicability.

[0005] The place which this invention was made such conventionally in view of the situation, and is made into the object is excellent in the high temperature strength (proof stress) demanded as a heat-resisting material in a pyrosphere 1100 degrees C or more, moreover is excellent in the oxidation resistance in the 800-1050-degree C temperature requirement in atmospheric air, and is to offer the iridium radical alloy with which the

plasticity demanded when raising further the workability which makes the thinning of an ingredient possible has been improved.

[0006]
[Means for Achieving the Goal]

the pure iridium from which this invention serves as the base in order to attain a technical problem -- platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- let it be a summary to come to carry out compound addition of the second element which consists of any these one sorts by dissolution within the limits (single phase) by dissolution within the limits (single phase) by addition or said second yuan prime factor kind. Moreover, the above-mentioned platinum, palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- addition of the second element which consists of any these one sorts By dissolution within the limits (single phase) which is 0.1 - 50wt% An addition total amount addition or said second yuan prime factor kind on the pure iridium used as the base Let it be a summary to come to carry out compound addition at the pure iridium used as the base by dissolution within the limits (single phase) which is 0.1 - 50wt%. Iridium is strengthened by solid-solution hardening with **** technical means. Moreover, the oxidation resistance of iridium is planned by generating the stability coat to oxidization hot [1500 degrees C or more] on the surface of iridium.

[0007] furthermore, the pure iridium used as the base -- as the second element -- a rhodium -- adding -- further -- as the third element -- platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts are added by dissolution within the limits (single phase), and let it be a summary for the addition total amount to the pure iridium of this third element and said second element to be dissolution within the limits (single phase). an alloy configuration -- rhodium of the second element of the above 0.1 - 30wt% of within the limits -- adding -- further -- the platinum of the third element, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts 0.1 - 20wt% of within the limits -- adding -- addition total amount of this third element and said second element Let it be a summary to have held down to dissolution [0.2 - 50wt% of] within the limits (single phase). the second element which consists of a rhodium according to the **** technical means and platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- the stability coat which was excellent in oxidation resistance on the surface of iridium with the addition in dissolution within the limits of the third element which consists of any these one sorts is generated. Thereby, oxidative consumption is the most intense in atmospheric air and a combustion gas ambient atmosphere. While being able to suppress extremely the oxidization consumption in 800-1050 degrees C, solid-solution hardening is brought about and iridium is strengthened. Furthermore, the plasticity which viscosity has also been improved and was excellent is acquired.

[0008]
[Embodiment of the Invention] The example of operation of this invention is explained based on a drawing. The graph which showed the effect of the second element which drawing 1 is an example of this invention iridium radical alloy concerning claim 1 thru/or 2, and is exerted on the hardness of iridium, Drawing 2 is the graph which showed the weight change accompanying the passage of time in a 1500-degree C exposure test, and is set to **** this invention. Platinum (Pt), palladium (Pd) to the pure iridium (Ir) used as the base, A rhodium (Rh), niobium (Nb), a tantalum (Ta), a hafnium (Hf), Titanium (Ti), a zirconium (Zr), an yttrium (Y), a lanthanum (La), molybdenum (Mo) -- addition of the second element which consists of any these one sorts dissolution [0.1 - 50wt% of] within the limits (single

phase) -- or said second yuan prime factor kind of addition total amount The need has held down to dissolution [0.1 - 50wt% of] within the limits (single phase). The addition of the second element or the addition total amount of the second yuan prime factor kind the reason In less than [0.1wt%], an anti-oxidation property, solid-solution hardenability, and viscosity are not improved, and plasticity (strip-processing nature) is not different from it of pure iridium in an anti-oxidation property list, that is, it is because the property of iridium is not improved. It is from on the other hand, causing the result to which it deposits, and the 2nd phase (intermetallic compound) carries out precipitation hardening, and is inferior to which also in about [that plastic working becomes difficult] and acid-proof ****, if the alloying element to pure iridium crosses the dissolution range.

[0009] therefore, platinum [as opposed to pure iridium at this invention], palladium, a rhodium, niobium, a tantalum, a hafnium, titanium, a zirconium, an yttrium, a lanthanum, and molybdenum -- addition of the second element which consists of any these one sorts Addition total amount of these [dissolution / 0.1 - 50wt% of / within the limits (single phase), or] second yuan prime factor kind It is desirable to consider as dissolution [0.1 - 50wt% of] within the limits (single phase). The inside of various kinds of second elements especially mentioned above, platinum (Pt), palladium (Pd), The niobium (Nb) except a rhodium (Rh), a tantalum (Ta), a hafnium (Hf), titanium (Ti), a zirconium (Zr), an yttrium (Y), a lanthanum (La), and molybdenum (Mo) -- if it is in the second element which consists of any these one sorts -- the addition -- less than [10wt%] -- or it is desirable to hold down the addition total amount of these second yuan prime factor kind to less than [10wt%].

[0010] every of the niobium and the hafnium with which the independent addition of the addition was made to be carried out by dissolution within the limits not more than 10wt% (single phase) to example 1 pure iridium here, an yttrium, a tantalum, and molybdenum -- specified quantity **** of the second element was carried out, and it ingoted with the arc solution process. Ir-Nb, Ir-Hf, Ir-Y, Ir-Ta, and Ir-Mo which were obtained by this -- after cutting the ingot of the shape of a carbon button of each alloy of these into the test piece of phi5mm and the shape of a cylinder with a height of 5mm by the wire cutting method and giving surface **** by the diamond file, the mechanical property (proof stress) of strength etc. was investigated. As mechanical characteristics of these alloys, Vickers hardness number is investigated and the result is illustrated to drawing 1 . Furthermore, a malleability test investigates deformation resistance hot [accompanying addition of the second element], and the result is illustrated to a table 1 as a deformation resistance value accompanying addition of the second element.

[0011] Although hardness shows solid-solution hardening which becomes high while the addition (dissolution concentration) of any alloy system of the second element increases so that clearly from drawing 1 , it turns out that the large thing of especially hardenability is the alloy system obtained by addition of niobium and a hafnium. And it turns out that as high a deformation resistance value as the addition of the second element increasing (dissolution concentration being high) is shown so that clearly from a table 1. That is, it is shown that reinforcement becomes high, so that the addition of each element increases also in that pure iridium is strengthened by solid-solution hardening and an elevated temperature. Therefore, as for the iridium radical alloy obtained by this example, it became clear low temperature and to excel in the mechanical property (proof stress) of strength etc. also in an elevated temperature further.

[0012] The addition to example 2 pure iridium carried out specified quantity **** of each second element of the niobium which is dissolution within the limits not more than 1wt%,

and was added, a hafnium, a tantalum, and molybdenum, and ingoted with the arc solution process. Ir-Nb, Ir-Hf, Ir-Ta, and Ir-Mo which were obtained by this -- oxidation resistance was investigated, after cutting the ingot of the shape of a carbon button of each alloy of these into the test piece of the shape of a cylinder mentioned above by the wire cutting method and giving surface **** by the diamond file. This oxidation resistance investigated that hardness change in the surface state of the test piece after carrying out predetermined time exposure of the test piece all over the furnace heated at 1500 degrees C, weight change, and a list. The result is illustrated to drawing 2 .

[0013] Ir-Nb, Ir-Hf, Ir-Ta, and Ir-Mo in which oxidation resistance was excellent compared with pure iridium so that clearly from drawing 2 -- although the alloy system of these shows the increase of weight and decreases after that for a short time, it turns out that the change is as small as an alloy excellent in oxidation resistance. That is, the stability coat to oxidization is generated by the front face, and the oxidation resistance of pure iridium is improved. Therefore, it became clear that the iridium radical alloy obtained by this example has the oxidation resistance which was excellent in the elevated temperature. In addition, although not shown in drawing, as for the case of the molybdenum addition to pure iridium, oxidation resistance is greatly improved for an addition about abbreviation 5wt%.

[0014] addition to example 3 pure iridium the palladium which is dissolution within the limits which is 0.1 - 5wt%, and was added, a tantalum, a lanthanum, and titanium -- every of these -- specified quantity **** of the second element was carried out, and it ingoted with the arc solution process. Ir-Pd, Ir-Ta, Ir-La, and Ir-Ti which were obtained by this -- plasticity was investigated, after cutting the alloy (ingot) of these into the test piece of the shape of a cylinder mentioned above by the wire cutting method and giving surface **** by the diamond file. The deformation resistance accompanying the addition of the second element and change of temperature investigated this plasticity. The result is illustrated to a table 2 as a deformation resistance value accompanying change of temperature at table 1 list.

[0015] It turns out that as low a deformation resistance value as there being few additions of the second element (dissolution concentration being low) is shown so that clearly from a table 1. And it turns out that such a low deformation resistance value is shown that temperature becomes high even if the addition of the second element increases so that clearly from a table 2. That is, the addition of the second element is stopped and the plasticity which was excellent when performing plastic working within the temperature (1250 degrees C of abbreviation) which does not cause secondary recrystallization (big-and-rough-izing of crystal grain) is shown. therefore, the iridium radical obtained by this example -- duality -- it became clear to excel also in the plasticity demanded when a system alloy raises workability.

[0016]
[table 1]

Addition of second element and high temperature flow stress

高温における第二元素の添加に伴う変形抵抗

合金	試験温度 (℃)	変形抵抗値 (kg／mm^2)
Ｉｒ－１％Ｐｄ	１２００	４８．１８
Ｉｒ－５％Ｐｄ	１２００	５１．６８
Ｉｒ－１％Ｔａ	１２００	５０．１３
Ｉｒ－５％Ｔａ	１２００	５１．９２
Ｉｒ－１％Ｌａ	１２００	５７．７７
Ｉｒ－５％Ｌａ	１２００	６５．７６
Ｉｒ－１％Ｔｉ	１２００	８３．３０

[0017]
[table 2]
High temperature resistance to deformation

温度の変化に伴う変形抵抗

合 金	試験 温度 (℃)	変形抵抗値 (kg/mm^2)
Ｉｒ－５％Ｐｄ	１０００	６１．２４
Ｉｒ－５％Ｐｄ	１２００	５１．６８
Ｉｒ－５％Ｐｄ	１４００	４３．４４
Ｉｒ－５％Ｔａ	１０００	６２．００
Ｉｒ－５％Ｔａ	１２００	５１．９２
Ｉｒ－５％Ｔａ	１４００	４３．４８

[0018] As described above, according to the iridium radical alloy of this invention concerning claim 1 thru/or 2, by solid-solution hardening being shown with the second element to add, it is common, but it turns out that the effects which it has with the class, and the addition (wt%) or an addition total amount (wt%) of the second element added about hardenability, high temperature strength (proof stress), oxidation resistance, and plasticity differ.

[0019] Drawing 3 is an example of this invention iridium radical ternary alloy concerning claim 3 thru/or 4. The graph which showed the relation of the workability (%) until a crack is macroscopically accepted in the side face of rolled stock and the addition total amount (wt%) to pure iridium (Ir) at the time of hot-rolling in the condition of having heated at 1200 degrees C, The oxidative consumption of pure iridium is the graph which showed the relation of the amount of oxidative consumption and exposure time in 1050 degrees C which becomes the most intense, and drawing 4 is set to **** this invention. On the pure iridium (Ir) used as the base, a rhodium (Rh) is added as the second element. Furthermore, as the third element, platinum (Pt), a ruthenium (Ru), a rhenium (Re), chromium (Cr), vanadium (V), and molybdenum (Mo) -- by adding any these one sorts by dissolution within the limits (single phase), and making the third element permute said a part of second element For example, it excels in oxidation resistance hot [1050-degree C], and the ternary alloy with which the plasticity demanded when raising workability moreover has been improved is ingoted.

[0020] And addition of the second element which consists of a rhodium to the pure iridium which serves as the base in this invention To 0.1 - 30wt% of within the limits furthermore, platinum, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- addition of the third element which consists of any these one sorts To dissolution [0.1 - 20wt% of] within the limits (single phase) And the total addition of the third element and the second element To stop, respectively is required for dissolution [0.2 - 50wt% of] within the limits (single phase). The addition of the second element this reason In less than [0.1wt%], oxidation resistance, solid-solution hardenability, and viscosity are not improved, and

thermal resistance and plasticity are not different from pure iridium, that is, it is because the property of iridium is not improved. It is because plasticity will worsen on the other hand if it becomes more than 30wt%. Moreover, the addition of the third element In less than [0.1wt%], it is because an anti-oxidation property, solid-solution hardenability, and each viscous improvement effect are small as mentioned above. if it becomes more than 20wt% on the other hand -- the 2nd phase (intermetallic compound) -- depositing -- being easy -- it is because plasticity worsens at an oxidation-resistant list. And the total addition to the pure iridium of the third element and the second element In less than [0.2wt%], it is because solid-solution hardenability is small and an anti-oxidation property and plasticity do not change it so much to it of pure iridium, either. It is because the 2nd phase (intermetallic compound) will deposit and plasticity will also worsen on the other hand at an anti-oxidation property list, if it becomes more than 50wt%.

[0021] Therefore, addition of the rhodium of the second element to the pure iridium which serves as the base in this invention To 0.1 - 30wt% of within the limits the platinum of the third element, a ruthenium, a rhenium, chromium, vanadium, and molybdenum -- any these one sorts of additions To dissolution [0.1 - 20wt% of] within the limits (single phase) And addition total amount of the third element and said second element It is desirable to hold down to dissolution [0.2 - 50wt% of] within the limits (single phase).

[0022] On the pure iridium used as the base, as the second element, a 15wt(s)% rhodium The Ir-15Rh-15Pt system alloy which ****(ed) so that the addition total amount of this third element and said second element might furthermore become 30wt(s)% to pure iridium including 15wt(s)% platinum as the third element, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The Ir-2Rh-3Ru system alloy which ****(ed) so that ruthenium 3wt% might be added as the third element, respectively and the addition total amount of both the element might become 5wt(s)%, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The ternary alloy of these is prepared. the Ir-2Rh-3Ru system alloy which ****(ed) so that rhenium 3wt% might be added as the third element, respectively and the addition total amount of both the element might become 5wt(s)% -- The ingot ingoted in the shape of a carbon button with the argon arc solution process is set in atmospheric air. Between heat or warm working, For example, it is an one pass in the condition of having heated at 1200 thru/or 1300 degrees C. It hot-rolls by 0.1% of reduction of sectional area. Plasticity is evaluated in quest of workability (%) until crack generating macroscopically accepted in the rolled stock side face accompanying rolling arises, and board thickness after that 0.5 to 0.01 mm The strip-processing nature was investigated performing strip processing until it resulted [from the sheet metal which is extent] in the foil. The result is illustrated to drawing 3 . Moreover, the board thickness obtained by this hot working Using the sheet metal which is 0.5mm, oxidative consumption chooses 1050 degrees C in the atmospheric air which becomes the most intense, investigates the amount of oxidative consumption by 20 hours, and illustrates that result to drawing 4 .

[0023] On the pure iridium used as the base, as the second element Moreover, rhodium 10wt%, The Ir-10Rh-1Mo system alloy which ****(ed) so that molybdenum 1wt% might be added as the third element, respectively and the addition total amount of both the element might become 11wt(s)% to pure iridium, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The Ir-2Rh-3Cr system alloy which ****(ed) so that chromium 3wt% might be added as the third element, respectively and the addition total amount of both the element might become 5wt(s)%, On the pure iridium used as the base, as the second element Moreover, rhodium 2wt%, The ternary alloy of these is prepared. the Ir-2Rh-3V system alloy which ****(ed) so that vanadium 3wt% might be

added as the third element, respectively and the addition total amount of both the element might become 5wt(s)% -- Also in the plasticity by hot rolling in the condition of having heated at 1200 thru/or 1300 degrees C in the atmospheric air which mentioned above the ingot ingoted in the shape of a carbon button with the argon arc solution process, and the amount of oxidative consumption in 1050 degrees C, to which oxidation becomes the most intense into atmospheric air, it investigated, respectively.

[0024] The workability (%) to crack generating of each alloy of a ternary system is understood that strip processing until it is improved rather than pure iridium and results [from sheet metal] in a foil is possible so that clearly from drawing 3 . That is, it became clear to excel in the plasticity demanded when viscosity is improved and each iridium radical ternary alloy obtained by this example raises workability. Moreover, although pure iridium has intense oxidative consumption so that clearly from drawing 4 , as for all the obtained ternary alloy, it turns out that oxidative consumption is stopped. That is, the stability coat to oxidization is generated by the front face, and the oxidation resistance of pure iridium is improved. Therefore, it became clear that the iridium radical ternary alloy obtained by this example has the outstanding oxidation resistance with which progress of oxidation in the temperature requirement especially whose oxidative consumption is most intense 1050 degrees C was suppressed in atmospheric air.

[0025] Therefore, the Ir-15Rh-15Pt system alloy obtained by this invention concerning claim 3 thru/or 4, An Ir-10Rh-1Mo system alloy, an Ir-2Rh-3Ru system alloy, an Ir-2Rh-3Ru system alloy, An Ir-2Rh-3Cr system alloy, an Ir-2Rh-3V system alloy, and all the iridium radical ternary alloy of these It became clear to excel in the plasticity demanded when raising the workability in the condition of having heated at 1200 thru/or 1300 degrees C in atmospheric air, and to excel in the oxidation resistance in 1050 degrees C to which the oxidative consumption of pure iridium moreover becomes the most intense into atmospheric air.

[0026]
[Effect of the Invention] Since it comes to constitute the iridium radical alloy of this invention like the above statement, it does the following operation effectiveness so.
** . Since it excels in the reinforcement (proof stress) hot [which is known from the former] demanded as a heat-resisting material in a pyrosphere 1100 degrees C or more, and oxidation resistance even if it compares with a nickel radical alloy, for example, the thinning by improvement in energy efficiency and the consolidation of an ingredient and a miniaturization are expectable. therefore, the iridium radical of this invention concerning claim 1 thru/or 2 -- duality -- according to the system alloy, the thinning by the improvement in energy efficiency and the consolidation of an ingredient, miniaturization of a device, and extension of a life are achieved. And since plasticity is excellent, plastic working can become easy, the escape of the application range as expansion material can be expected, and useful and practical effectiveness can be expected greatly. Furthermore, in the conventional heat-resisting material, since the application beyond the temperature of 1100 degrees C or more which was not able to be used opens, much effectiveness, like the economical effectiveness by the escape of the application range is also large is expectable.

[0027] ** . It sets in atmospheric air or a combustion gas ambient atmosphere, and oxidization consumption becomes the most intense. The property of the pure iridium in 800-1050 degrees C Addition of the rhodium of the second element and the platinum of the third element, a ruthenium, a rhenium, The addition in any these 1 sorts of dissolution within the limits (single phase) improves greatly. chromium, vanadium, and molybdenum --

It excels also in the hot oxidation resistance demanded as a heat-resisting material in a pyrosphere 1100 degrees C or more, and the iridium radical ternary alloy of the solid-solution hardening mould excellent in plasticity is obtained. Therefore, since it excels in oxidation resistance iridium radical ternary alloy ****** of this invention concerning claim 3 thru/or 4, and hot [800-1050-degree C], the escape of the application range as a heat-resisting material is expectable. and the oxidation resistance as a heat-resisting material -- in addition, since it excels also in the plasticity demanded when planning plastic working, the thinning of an ingredient is expectable. For example, board thickness 0.5 to 0.01 mm It becomes processible [from the sheet metal which is extent to a foil]. Therefore, since the escape of the application range as expansion material is also expectable, much effectiveness, like expectation of the economical effectiveness by the escape of the application range is great is also expectable.